Direct and legacy effects of dry winter on photosynthesis in a semi-arid grassland

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Introduction

Southern areas of U.S., especially the Southwest, are projected to became direr in the winter and spring (Fig. 1). Lack of rainfall in the usually wet winter may originate severe droughts which are a main cause of inter- and intra- annual variation in carbon sequestration. However, the effects of dry winter/spring on photosynthesis remains understudied .

Here we conducted RainManSR to evaluate the impacts of dry wind/spring on ecosystem photosynthesis.

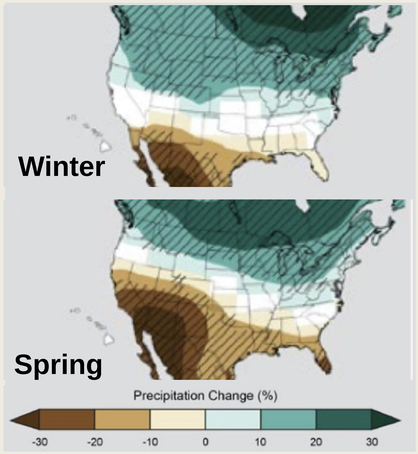

Fig. 1 Projected future changes in precipitation. (Source: U.S. National Climate Assessment)

Results

Lower soil moisture under dry winter

- Soil moisture at surface and middle depth decreased under W1 (dry winter) in winter.
- Soil moisture in summer were similar between treatments.

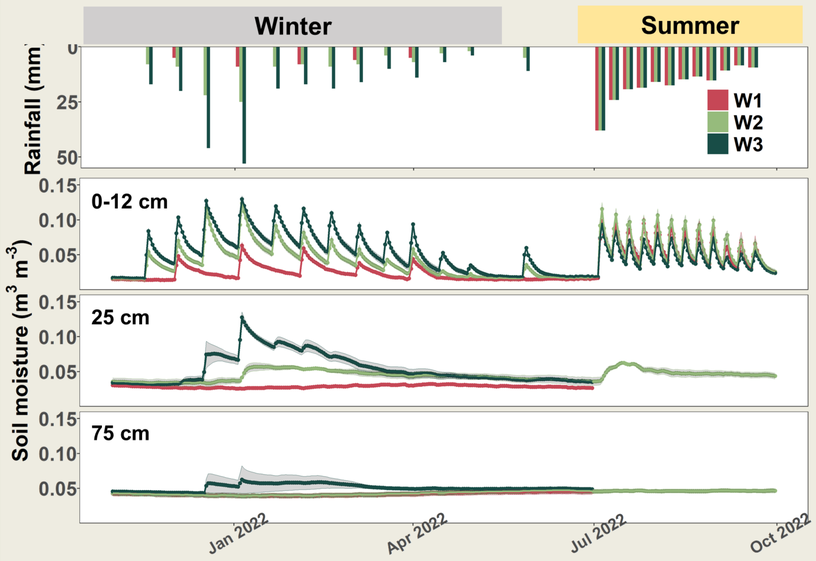

Fig. 2. Experimental rainfall applications (mm, bars) and daily soil moisture (m3/m3 , lines) at three depths during experiment.

GPP was lower in winter but higher in summer

- GPP had similar seasonal dynamics between treatments;
- GPP under W1 was lower over the winter but higher in the middle summer.

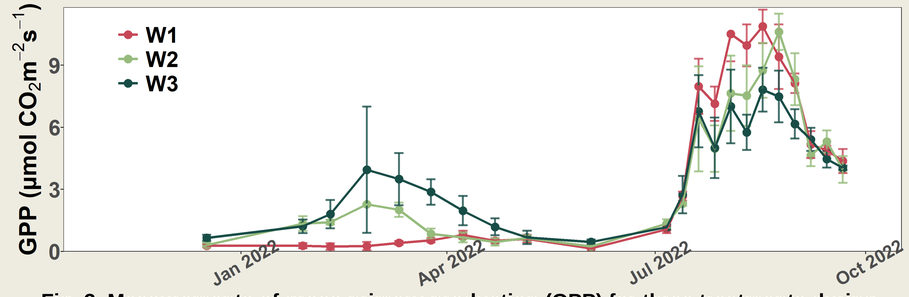

Fig. 3 Measurements of gross primary production (GPP) for three treatments during winter and summer.

Higher GCC in summer

- GCC increased under W1 during summer.

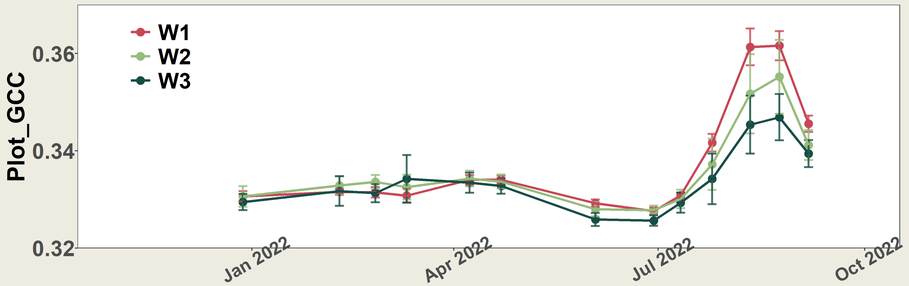

Fig. 4 Measurements of greenness (GCC) for three treatments during winter and summer.

Seasonal response

- Dry winter decreased winter GPP but increased summer GPP and summer GCC.
- Wet winter increased winter GPP and had no impacts on summer GPP or GCC.

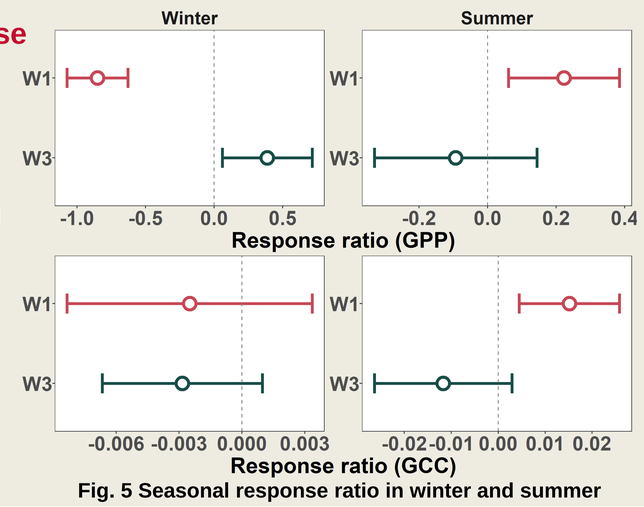

Fig. 5 Seasonal response ratio in winter and summer

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Reason 1-- Recovery of annual grass

- Annual grass cover increased under W1 in summer, while it was close to 0 in winter.

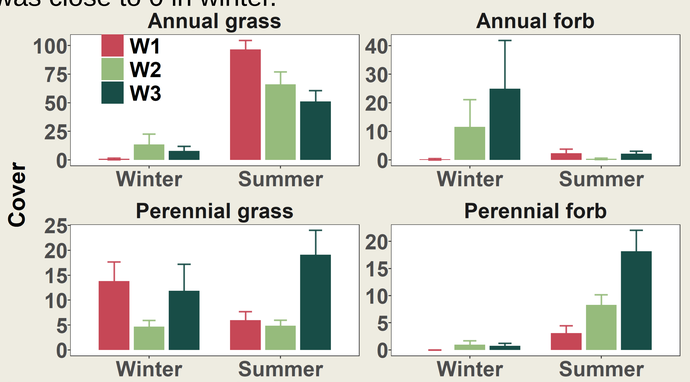

Fig. 5 Vegetation cover for three treatments in winter and summer.

Reason 2– Increased nutrient input

- Dry winter would lead to accumulation of soil nutrients.
- Standing dead and litter decomposition in winter would provide a source of nutrients to increase summer GPP.

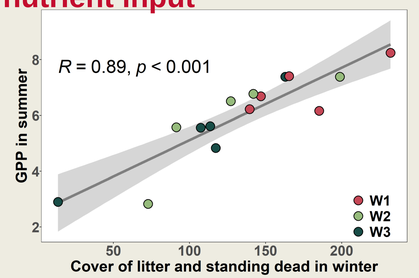

Fig. 6 The relationship between GPP and cover of standing dead and litter.

Reason 3– Changed community composition

- Dry winter significantly affected plant community composition in winter, but not in summer

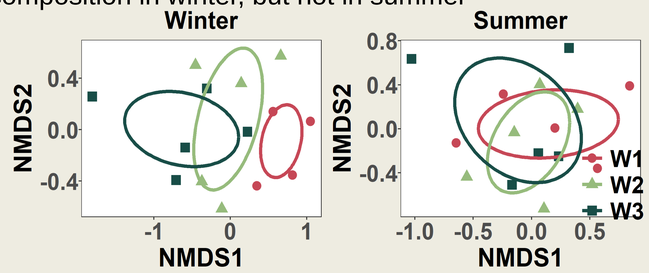

Fig. 7 Non-metric multidimensional scaling (NMDS) of plant community composition in winter and summer

Conclusion

Dry winter decreased GPP in winter, but increase GPP in summer by recovery of annual grass, increased nutrient input, and changes in community composition.